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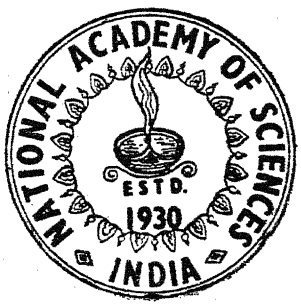

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SULPHUR REQUIREMENTS OF TWO SPECIES OF PHYLLOSTICTA

By

R. N. TANDON *and* K. S. BILGRAMI

Botany Department, Allahabad University

Received on 19th August, 1958

The importance of sulphur in the nutrition of fungi has been demonstrated by various workers including Rabinovitzsereni (1933), Tandon (1950) and Grewal (1954) who reported that a number of the organisms with which they worked failed to grow on a medium which did not contain sulphur. Armstrong (1921), Volkonsky (1933) and Saksena *et al* (1952) reported that fungi could grow on a large number of sulphur sources. On the basis of sulphur metabolism, Fischer classified the micro organisms into two categories. These subdivision have been based mostly on the results of Lwoff (1932). Those which obtained their sulphur from sulphate ions were called "Euthiotrophic" and those which were unable to utilize sulphate were called "Parathio-trophic". Mothes (1938) found that sulphur metabolism of *Aspergillus niger* was more or less similar to that of green plants.

Leonian and Lilly (1938) working with a number of *Saprolegniales* observed that magnesium sulphate was a poorer source of sulphur than l—cystein. Volkonsky (1934), Dayal (1942), Bose (1943) and Bhargava (1945) obtained similar results with the fungi studied by them also. Our knowledge about the relative importance of sulphur sources is still very inadequate. It was, therefore, considered desirable to study the sulphur requirements of *Phyllosticta cycadina* (Pass) and *P. artocarpina* (Syed et Butl).

MATERIALS AND METHODS

The cultures of *Phyllosticta cycadina* and *P. artocarpina* of previous investigations (1957) were used for the present studies also. Magnesium sulphate which was the source of sulphur in the basal medium* was replaced by 10 different sources of sulphur. The pH in each case was adjusted to 5·2 which gave best growth of both the organizms. Mycelial growths were determined after growing on 25 ml of autoclaved liquid nutrient contained in 150 ml Erlenmeyer flasks. The cooled medium was inoculated with 3 mm agar plugs of the mycelium. After 15 days incubation at 25°C ± 1 the fungal colonies were filtered, dried to a constant weight and weighed. Average dry weight in each case has been based on the results obtained from 4 replicates. The dry weights were statistically analysed by the method used by Tandon and Bilgrami (1957) and were distinguished into three broad categories *viz.* good, moderate and poor. The degree of sporulation has been grouped into 4 classes on the basis of the number of spores present under low power field of the microscope, *viz.* poor (1-10 spores), fair (11-20 spores), good (21-30 spores), excellent (above 30 spores).

OBSERVATIONS

The dry weights and sporulations are recorded in Table 1.

TABLE 1

Showing dry weight in Mgs and sporulation of *Phyllosticta cycadina* and *P. artocarpina* on media containing different sulphur sources.

Sulphur compounds	*P. cycadina*		*P. artocarpina*	
	Dry wt. in mgs.	Sporulation	Dry wt. in mgs.	Sporulation
1. Magnesium sulphate	83·0	Excellent	93·0	Excellent
2. Potassium sulphate	68·0	Good	72·0	Good
3. Amm. sulphate ...	38·0	Absent	37·0	Absent
4. Zinc sulphate ...	0·0	...	0·0	...
5. Sod. bisulphate ...	70·0	Fair	63·0	Good
6. Sod. bisulphite ...	49·0	Fair	53·0	Fair
7. Sod. thiosulphate ...	60·0	Poor	85·0	Poor
8. Potassium per sulphate	61·0	Poor	67·0	Poor
9. Thiourea ...	30·0	Poor	44·0	Poor
10. Cystein ...	80·0	Good	88·0	Fair
11. No sulphur ...	0·0	...	0·0	...
Average ...	49·0		54·7	

* $MgSO_4.7H_2O$ 0·75 gm, KH_2PO_4 1·75 gms, KNO_3 3·5 gms, dextrose, 5·0 gms and double distilled water 1 litre.

Summary of the dry weight results

1. *Phyllosticta cycadina*

Treatments	...	highly significant
Replicates	...	non significant
S. E.	...	C. D. at 1% level
1·179	...	4·58

Dry weight in mgs.

Magnesium sulphate	Cystein	Sod. bisulphate	Potassium sulphate
83·0	80·0	70·0	68·0

Pot. persulphate	Sod. thiosulphate
61·0	60·0

Sod. bisulphate	Amm. sulphate	Thiourea	Zinc sulphate	No sulphur
49·0	38·0	30·0	0·0	0·0

2. *Phyllosticta artocarpina*

Treatments	...	highly significant
Replicates	...	non significant
S. E.	...	C. D. at 1% level
1·345	...	5·23

Dry weight in mgs.

Magnesium sulphate	Cystein	Sod. thiosulphate
93·0	83·0	85·0

Pot. sulphate	Pot. persulphate	Sod. bisulphate	Sod. bisulphite
72·0	67·0	63·0	53·0

Thiourea	Amm. sulphate	Zinc sulphate	No sulphur
44·0	37·0	0·0	0·0

A critical examination of the above table shows that magnesium sulphate and cystein were best sulphur sources. They produced good mycelial growth on potassium sulphate, sodium thiosulphate, sodium bisulphate and potassium persulphate. Ammonium sulphate and thio-urea were poor sources of sulphur, while sodium bisulphite was a moderate one for both the species of *Phyllosticta*. Zinc sulphate or a medium devoid of any sulphur source did not support any growth of these two organisms.

The results from the above table also indicate that magnesium sulphate was not only best source for growth but it was excellent for sporulation also. The organisms exhibited good sporulation on potassium sulphate. Ammonium sulphate could not induce sporulation of both the species. These fungi exhibited poor sporulation on potassium per sulphate, sodium thiosulphate and thiourea. Sodium bisulphate was good for the sporulation of *P. artocarpina* and fair for *P. cycadina,* while sodium bisulphite was a fair source for the sporulation of both the species. Good sporulation of *P. cycadina,* and fair of *P. artocarpina* was recorded on cystein.

DISCUSSION

It is clear from the present records that both *Phyllosticta cycadina* and *P. artocarpina* were incapable of growing on a medium which was devoid of sulphur and in this respect they were similar to *Alternaria tenuis* (Rabinovitz, 1933), *Gloeosporium musarum* (Grewal, 1954), and *Pestalotia malorum* (Tandon, 1950). These species differed from the organisms studied by Steinberg (1941), Srivastava (1951) and Agarwal (1955) who found that *Aspergillus niger, Curvularia lunata* and *C. penniseti* respectively produced some growth even in absence of any source of sulphur in the medium.

Mosher *et al* (1936), Tandon (1950) and Agarwal (1955) have reported that sulphates are good sources of sulphur for *Trichophyton interdigitale, Pestalotia psidii* and *Curvularia penniseti* respectively. In the present investigations, however, all the sulphates were not found equally favourable for the growth of these fungi. Magnesium sulphate and potassium sulphate were good sources while ammonium sulphate was a poor one. Agarwal (1955) also reported it to be a poor source for *Fusarium coeruleum.* None of these species were capable of growing on zinc sulphate. These fungi showed good growth on cystein and in this respect they resembled *Pestalotia psidii* and *Pythium arrhenomanes* investigated by Tandon (1950) and Saksena *et al* (1952). Potassium per sulphate was a good source for both the species of *Phyllosticta.* Agarwal (1955) reported that *Curvularia penniseti* was unable to assimilate it and in this respect these organisms differed from *C. penniseti.* Sodium bisulphite supported good growth of these two fungi and their behavior was thus similar to that of *Fusarium coeruleum* (Agarwal, l. c.). The effect of sodium thiosulphate was similar to that on fungi investigated by Saksena *et al* (1952) and Agarwal (l. c.). Agarwal (1955) reported that *Fusarium coeruleum* was unable to grow on thiourea, but the organisum under investigation differed from the above mentioned fungi because they could utilize this substance.

It is also evident that different sources of sulphur markedly influenced the sporulation. There was no correlation between growth and sporulation. It was noted that when the growth was good, the sporulation could range from poor to excellent.

SUMMARY

The influence of ten different sources of sulphur was studied on the growth and sporulation of *Phyllosticta cycadina* and *P. artocarpina.*

Magnesium sulphate and cystein were best sources. Good mycelial growth was also attained on potassium sulphate, sodium thiosulphate, sodium bisulphate and potassium persulphate. Sodium bisulphate was a moderate source, while ammonium sulphate and thiourea were significantly poor sources for both the orgnisms. These fungi failed to grow on zinc sulphate or on media which were devoid of any sulphur.

Magnesium sulphate and potassium sulphate supported excellent and good sporulation respectively of both the species. Poor sporulation was recorded on

potassium persulphate, sodium thio-sulphate and thiourea. There was no sporulation on ammonium sulphate. Sodium bisulphate was good and fair for the sporulation of *P. artocarpina* and *P. cycadina* respectively, while sodium bisulphate was fair for both the species.

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*Originals not consulted.

THE CULICINE FAUNA OF CHOTANAGPUR PLATEAU (BIHAR)

PART-I-CULEX (CULEX) LINN.

By

P. N. MEHROTRA

University Department of Zoology, Ranchi College, Bihar University, Ranchi

(Communicated by Dr. K. C. Bose).

Read at the 27th Annual Session of the Academy held at the University of Jabalpur on 27th December, 1957.

TOPOGRAPHY

Chotanagpur plateau makes the southern half of the state of Bihar and comprises the districts of Ranchi, Hazaribagh, Palamu, Dhanbad, Singhbhum and the Santhal parganas, southern parts of Gaya district and the hills of Kharagpur. It is a continuation of the Deccan plateau situated between 83° - 20″ - 87° - 45″ longitude and 25° - 15″ - 20° - 20″ latitude and covers an area of 30,000 sq. miles.

Physiographically Chotanagpur may be divided into the following regions.

(1) *Pat region*—It is a laterite plateau, much broken and flat topped with the summits covered with jungles, the average height being 3000' above see level. This is one of the rainy areas, the average rainfall being 80″ - 90″ and is covered with jungles. The chief breeding sources of mosquitoes in this region are hill streams with innumberable holders strewn over their beds and holding pockets of water. In this region collections were made from Netherhat, Banari, Bishunpur, Khurd and Chainpur.

(2) *Ranchi and Upper Hazaribagh plateau*—This is an intensively cultivated plain with undulating surface and terraced fields. The average h ight above sea level is 2000' and average rainfall 50″ - 60″.

In this region collections were made from Ranchi and Hazaribagh towns, Rampur, Murgu, Gumla, Dasham, Hirnu, Horhapp, Palandu tea plantations, Nagpheni, Sissai, Rerwa, etc.

(3) *Thousand feet plateau*—This region carries most of the forested areas of Chotanagpur, is thickly populated and includes lower Hazaribagh, South Monghyr and Singhbhum. In this region collections were made mainly from Purulia, Chatra, Chaibasa, Kodarma, Jagannathpur and Chakradhapur.

(4) *Damodar and Suwarnrekha valley*—This is a faulted rift valley surrounded by lac producing forests and the average height of this region is 500' above sea level.

(5) *Rajmahal hills and Ch tanagpur fringe*—This densely forested region represents the eroded margin of the plateau and represents the transition zone between plateau and plains. The approximate height above sea level is 500-1000'.

In this region collections were made from Pakaur, Jhalda, Purulia, Kharagpur, Jamalpur etc.

MATERIAL AND TECHNIQUE

The material for study was either reared in the laboratory from the larvae collected in large numbers from different places or by catching adults by sweeping insect net in foliage and other vegetation near the breeding places, human dwellings, cowsheds etc. Larvae from water containing plants were collected by siphoning the water contents of the plants and repeated washing which increased the larval collections considerably. The larvae from water surfaces were collected by skimming the surface with an ordinary dipper.

In almost all cases the male genitalia were examined to confirm the identification.

C. EPIDESMUS THEOBALD, 1910

This is one of the commonest species found in the entire plateau except the Pat region. Adults were mostly caught from dark corners in cowsheds at Horhapp, Hirni, Gumla, Namkum, Chaibasa, Jhalda, Ranchi town and Pakaur. A few specimens were collected from nearby dwellings also. They were found breeding in stagnant water along the margins of lakes, tanks, swamps and in the weed infested ponds. This species has previously been recorded from Katihar, Purnea Bhogaon (Theobald, 1910), Pusa (Barraud, 1924; Senior white, 1923) and is supposed to be common in Bihar (Barraud, 1934).

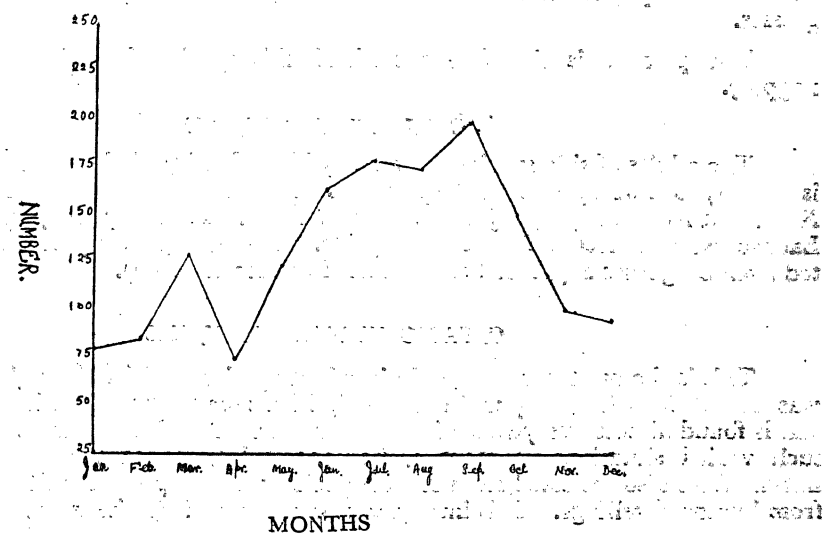

Fig. 1. Collections of C. epidesmus at Ranchi.

C SINENSIS THEOBALD, 1903

Adults were reared from the larvae collected from water accumulated in low lying fields, ditches and road side temporary storages of water, mainly from Ranchi town, Murgu and Kodarma but apparently this species seems to be of rare occurrence. The previous records of distribution of this species in the state are as follows—Kierpur and Katihar, Purnea district (Paiva); Pusa and Baiighai near Puri (Annandale 1908 & Annandale and Graveley, 1911).

C. EDWARDSI BARRAUD, 1923

This species like the previous one is not very common in this plateau. Adults and larvae were mostly collected from the tea plantations Palandu. A few specimens were also collected from Sissai, Nagpheni and Chakradharpur. Their bite is quite irritating. They breed in narrow pits along roadside and in the wells.

This is the first record of this species from Bihar.

C. BITAENIORHYNCHUS, GILES, 1901

This species is in the entire plateau Adults were collected from Dasham, Hirni, Sissai, Nagpheni, Pakaur and Purulia, from cowsheds and human dwellings alike. Larvae were collected from stagnant waters, drains, buffalo wallos and in especially large numbers from a rice field prior to harvest at Sissai. The previous records of this species from Bihar are those of Senior White (1923) from Pusa and Barraud (1924) from Singhbhum.

C. BARRAUDI EDWARDS, 1922

This is a very cemmon species in the Pat region. Adults were collected at Netherhat (3600), Banari and Bishunpur from cattle sheds and dilapidated houses only. No specimens were found in the human dwellings. This species does not seem to prefer darkness. Adults were also reared in the laboratory from fresh water collections on the hills as well as stagnant temporary collections in the jungle. Larvae and pupae were collected sticking to lower parts of stem of aquatic grasses.

The present is the first record of this species from Bihar State (Chotanagpur).

C. MIMETICUS NOE, 1899

The adults of this species are readily identified by their spotted wings. This is mainly a hill species and specimens were collected from Forest Rest house, Netharhat from hanging objects in the bed room. Probably they prefer darkness. Larvae were collected from stream pools. This species has previously been collected from Singhbhum (Record of Malaria Institute of India).

C. FATIGANS WIEDEMANN, 1828

This is the most common and abundant species of *Culex* throughout India and was found in Chotanagpur in Ranchi, Hazaribagh, Purulia, Kodarma, Chaibasa and is found almost everywhere in Chotanagpur. The larvae were collected from such varied situations as ditches, bamboo poles, stagnant waters, rice fields etc. Larvae were also collected from stream pools at Horhapp. Adults were collected from human dwellings. It is known vector of filariasis in the area.

C. HUTCHINSONI BARRAUD, 1924

Adults were reared in the laboratory from larvae collected from stagnant collections of water in small ditches in the fields at Netarhat. Adults were collected from nearly vegetation and cowsheds also, but were not as common in this region as *C. Barraudi* and *C. mimeticus*. They were not found in human dwellings.

This species has been previously recorded only from Nongpoh, Khasi Hills district of Assam.

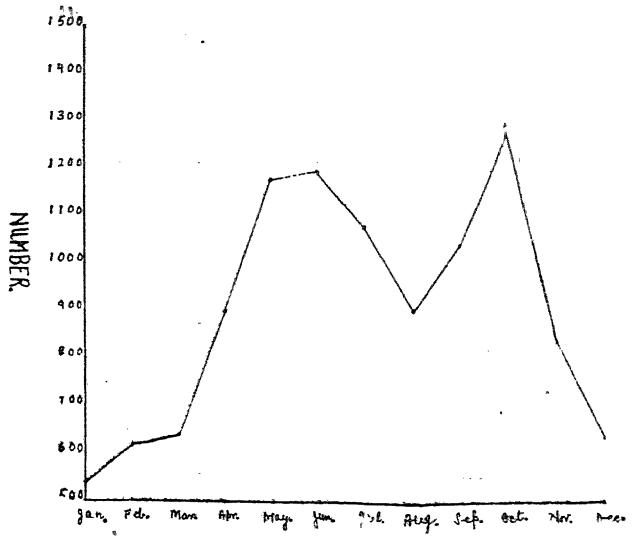

Fig. 2. Collections of C. fatigans at Ranchi.

C. FUSCITARSIS BARRAUD, 1924

The larvae were collected from wells and small stream beds overshaded by trees. Adults were collected from human dwallings and cowsheds alike. This is one of the commonest species of *Culex* in Ranchi and Hazaribagh and has been previously recorded from this place as referred to by Barraud (1934).

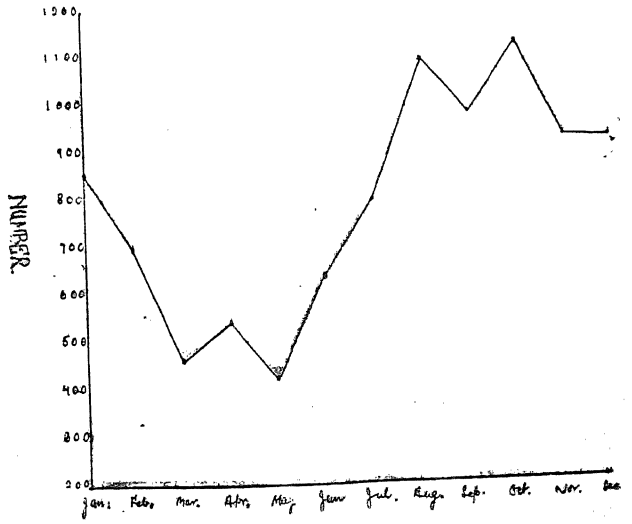

Fig. 3. Collections of C. fuscitarsis at Ranchi.

ACKNOWLEDGEMENTS

The author is most grateful to Principal G. P. Dube, Ranchi College for constant encouragement and appreciation bestowed to carry on the work and to Prof. P. Buxton F. R. S. for confirming the identification of specimens sent to him. I am also indebted to Dr. K. C. Bose for going through the manuscript and valuable advice and to Dr. E. Ahmad for physiographical information about Chotanagpur.

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FUNGI OF AJMER (RAJASTHAN)—III

By

N. C. JOSHI

Botany Department, Government College, Ajmer

(Received on 19th July, 1958)

This paper is intended to record some more fungi as a part of study of the Fungus flora of Ajmer undertaken by the author (Joshi 1956, 1957). The collections have been kept in the Mycology Herbarium of the Botany Department, Government College, Ajmer and some interesting ones have been deposited at Commonwealth Mycological Institute, Kew, Surrey, England and Herb. Crypt. Ind. Orient of the Indian Agricultural Research Institute, New Delhi.

PHYCOMYCETES

85. *Phytophthora parasitica* Dastur (Sacc.* XXIV:37, B & B**. 6)

On the living leaves and shoots of *Sesamum indicum* (Pedaliaceae), fields near Foysagar, 3-9-56, Leg N. C. J., Mycol. Herb. No. 85 (Conidial stage and oosporic stages.)

86. *Plasmopara viticola* Berkeley and Curtis (Sacc. VII:239, B & B., 6).

On the living leaves of *Vitis vinifera* (Vitaceae), Pushkar, 12-3-56, Leg L. N. T., Mycol. Herb. No. 86 (Conidial stage only).

87. *Perenospora arborescens* (Berk) de Bary (Sacc. VII:251, B & B., 4).

On the living leaves of *Argemone maxicana* (Papavaraceae), civil lines, 1-2-56, Leg N. C. J., Mycol. Herb. No. 87 (Conidial stage).

88. *Perenospora trifoliorum* de Bary (Sacc. VII:252, B & B., 4).

On the living leaves of *Melilotus alba* (Leguminosae), Lohagal road, 3-1-57, Leg N. C. J., Mycol. Herb. No. 88 (conidial stage).

89. *Synchytrium rhytzii* Syd (Sacc. XXI:840, B & B., 1).

On the living leaves, petiole and stem of *Leucas aspera* (Labiateae), Pushkar, 6-3-56, Leg N. C. J., Mycol. Herb. No. 89 (winter and summer spores abundantly present).

90. *Pythium aphanidermatum* (Edson) Fitzpatrick (Sacc. XXIV:1332, B & B., 6).

Isolated from the infected roots of *Lagenaria vulgaris*, Kishangargh Road, 3-8-56., Mycol. Herb. No. 90 (Conidial stage only).

91. *Cunninghamella elegans* Lendner (Sacc. XXI:828, B & B., 8).

Isolated from the soil of Ajmer (Culture developed abundant conidiophores bearing conidia).

*Sacc.—Saccardo, P.A.

** B & B—Butler, E. J. & Bisby, G. R.

ASCOMYCETES

92. *Protomycopsis patelli* Pavgi and Thirumalachar (Pavgi and Thirumalachar 1953).

On the living leaves of *Phaseolus radiatus* (Leguminosae), Adarshnagar, 13-10-56, Leg N. C. J., Mycol. Herb. No. 91 (resting spores observed).

93. *Pseudopeziza medicaginis* (Lib) Sacc (Sacc. VIII:724, B & B., 13).

On the living leaves of *Medicago sativa* (Leguminosae), Lohagal road, 4-5-56, Leg N. C. J., Mycol. Herb. No. 92 (Perithecial stage).

94. *Chaetomium indicum* Corda (Sacc. 1:222, B & B., 19).

On the decayed paper at Botany laboratory, Government College, Ajmer, 6-2-57, Leg N. C. J., (Perithecial stage).

95. *Xylaria obovata* Berk (Sacc. 1:317, B & B., 42).

On the dead wood, Botany Garden, 3-2-56, Leg N. C. J., Mycol. Herb. No. 93 (Ascigerous stage).

96. *Phyllachora sorghi* v. Hoehn (Sacc. XXII:426, B & B., 35).

On the living leaves of *Sorghum vulgare* (Gramineae), Pushkar, 13-9-56, Leg N. C. J., Mycol. Herb. No. 94 (Perithecial stage).

BASIDIOMYCETES

97. *Entyloma oryzae* Syd. (Sacc. XXIII:625, B & B., 44, M & T**., 69).
In the living leaves of *Oryza sativa* (Gramineae), Jawaja (Ajmer), 12-9-56, Leg N. C. J., Mycol. Herb. No. 95 (Teliospores present).

98. *Entyloma nymphaeae* (Cunningham) Setch. (B & B., 44, M & T., 69).

In the living leaves of *Nymphaea lotus* (Nymphaeaceae), Budha Pushkar (Ajmer), 14-11-56, Leg N. C. J., Mycol. Herb. No. 96 (Teliospores abundant).

99. *Entyloma mysorensis* Thirum. (M & T., 69).

In the living leaves of *Scirpus* Sp. (Cyperaceae), Pushkar, 1-11-57, Leg N. C. J., Mycol. Herb. No. 97 (Teliospores present).

100. *Entyloma dahliae* Syd. (Green 1932, M & T., 68).

In the living leaves of *Dahlia* Sp. (Compositeae), Botany garden, 1-11-56, Leg N. C. J., Mycol. Herb. No. 98 (Teliospores present abundantly inside the host).

101. *Entyloma spermacocae* ***

In the living leaves of *Spermacoce hispida* (Rubiaceae), 1-9-55, Leg N. C. J., Todgargh, Mycol. Herb. No. 99 (Teliospores present).

** M & T—Mundkur, B. B. & Thirumalachar M. J.

*** Personal communication recived from Dr. M. J. Thirumalachar who has reported this fungus.

102. *Sphacelotheca panjabensis* Sydow apud Sydow and Ahmad (M & T., 18).

In the overies of *Cenchrus setigerus* (Gramineae), Pachkund, 10-11-56, Leg N. C. J., Mycol. Herb. No. 100 (Teliospores present).

103. *Cintractia cyperi* Clinton (M & T., 42).

In the spikelets and peduncle of *Cyperus* Sp. (Cyperaceae), Pushkar, 3-9-53, Leg N. C. J., Mycol. Herb. No. 101 (Teliospores present).

104. *Uromyces commelinae* Cke (Sacc. VII:573, B & B., 81).

On the living leaves of *Commelina benghalensis* (Commelinaceae), Foysagar, 13-9-57, Leg N. C. J., Mycol. Herb. No. 102 (Uredo and teleuto stages).

105. *Uromyces hobsoni* Vize (Sacc. VII:583, B & B., 82).

On the living leaves of *Jasminum* Sp. (Oleaceae), Pushkar, 23-10-57, Leg N. C. J., Mycol. Herb. No. 103 (teleuto stage).

106. *Uromyces striatus* Schroet (Sacc. VII:5 2, B & B., 84).

On the living leaves of *Medicago sativa* (Leguminosae), Foysagar, 11-1-56, Leg N. C. J., Mycol. Herb. No. 104 (Uredo and teleuto stages).

107. *Uromyces appendiculatis* (Pers) Link (Sacc. VII:535, B & B., 81).

On the living leaves of *Phaseolus* Sp. (Leguminosae), Adarshnagar, 12-11-57, Leg N. C. J., Mycol. Herb. No. 105 (Uredo and teleuto stages).

108. *Uromyces anthyllidis* (Grev.) Schroet. (Sacc. VII:551, B & B., 81).

On the living leaves of *Trigonella foenum-graecum* (Leguminosae), Beer village, 14-2-57, Leg N. C. J., Mycol. Herb. No. 106 (Uredo and Teleuto stages).

109. *Puccinia penniseti* Zimmerm. (Sacc. XVII:390, B & B., 71).

On the living leaves of *Pennisetum typhoideum* (Gramineae), Gulab Bari, 10-10-1957, Leg N. C. J., Mycol. Herb. No. 107 (Uredo and teleuto stages).

110. *Puccinia maydis* Bereng. (Sacc. VII:659, B & B., 70).

On the living leaves of *Zea mays* (Gramineae), Pushkar, 16-10-57, Leg N. C. J., Mycol. Herb. No. 108 (Uredo and teleuto stages).

111. *Revenelia emblicae* Syd. (Sacc. XXI:744, B & B., 76).

On the living leaves of *Phyllanthus emblica* (Euphorbiaceae), 13-3-56, Leg N. C. J., Mycol. Herb. No. 109 (Uredo and Teleuto stages).

DEUTEROMYCETES

112. *Gercospora solanacea* Sacc. (Sacc. IV:449, B & B., 143).

On the living leaves of *Solanum melongena* (Solanaceae), Pushkar, 6-8-56, Leg N. C. J., Mycol. Herb. No. 110.

113. *Cercospora pulchra* Syd. (Mundkur 1938:32).

On the living leaves of *Crataeva religiosa* (Capparidaceae), Kekri, 9-3-56, Leg N. C. J., Mycol. Herb. No. 111.

114. *Lacellina graminicola* (Berk. and Br.) Petch. (Subramanian 1952).

Syn. *Mesobotrys graminicola* (Berk. and Br.) Sacc.

On the dead twigs of *Saccharum spontaneum* (Gramineae), Pushkar, 10-2-56, Leg N. C. J., Mycol. Herb. No. 113.

115. *Acrothecium penniseti* Mitra (B & B., 139).

On the living leaves of *Pennisetum typhoideum* (Gramineae), Foysagar, 18-10-57, Leg N. C. J., Mycol. Herb. No. 114.

116. *Helminthosporium sacchari* Butler (B & B., 147).

On the living leaves of *Saccharum officinarum* (Gramineae), Budha Pushkar, 13-11-57, Leg N. C. J., Mycol. Herb. No. 115.

117. *Alternaria longipes* (Mundkur 1938).

On the living leaves of *Nicotiana tabacum* (Solanaceae), Monoharpura, 2-2-56, Leg N. C. J., Mycol. Herb. No. 118.

118. *Colletotrichum inamdarii* Lal (Lal and Singh 1953).

On the living leaves of *Carissa carandus* Linn (Apocynaceae), Beawar, 11-3-56, Leg N. C. J., Mycol. Herb. No. 119.

119. *Colletotrichum nigrum* Ell. and Hals. (Sacc. XXII:1203, B & B., 153).

On the living leaves of *Capsicum annum* (Solanaceae), 11-9-56, Leg N. C. J., Mycol. Herb. No. 120.

120. *Colletotrichum falcatum* Went (Sacc. XI:570; B & B., 153).

On the living leaves and clumps of *Saccharum officinarum* (Gramineae), 1-2-57, Leg N. C. J., Mycol. Herb. No. 121.

121. *Colletotrichum graminicolum* (Ces.) Wilson (B & B., 153).

On the living leaves of *Andropogon sorghum* (Gramineae), 17-9-56, Leg N. C. J., Mycol. Herb. No. 122.

122. *Septoria arcuata* Cke (Sacc. III:499, B & B., 162).

On the living leaves of *Ficus* Sp. (Moraceae), 10-2-57, Leg N. C. J., Mycol. Herb. No. 123.

123. *Phyllosticta sorghina* Sacc. (Sacc. III:61., B & B., 163).

On the living leaves of *Andropogon sorghum* (Gramineae), 1-9-56, Leg N. C. J., Mycol. Herb. No. 124.

ACKNOWLEDGEMENT

I am grateful to Dr. S. P. Wiltshire, formerly the Director Commonwealth Mycological Institute England for sending some exsiccati for comparision and study. My thanks are due to Principal and Prof. B. Tiagi for laboratory facilities.

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ENTOMOLOGICAL SURVEY OF THE HIMALAYA

PART XXIX.—ON A COLLECTION OF NIVAL CHIRONOMIDAE (DIPTERA) FROM THE NORTH-WEST (PUNJAB) HIMALAYA*

By

SANTOKH SINGH

School of Entomology, St. John's College, Agra.

(Received on 4th July 1958)

This paper deals with a part of the Chironomidae from the nival zones of the North-West Himalaya, collected by Prof. Mani's Entomological Expeditions to the Himalaya from the School of Entomology, St. John's College, Agra. Six new species are described here. The genera *Brillia* Kieff. and *Orthocladius (Pseudorthocladius)* Geoth. are being recorded here for the first time from India. The species dealt with here represent ecologically transitional forms, inhabiting the nival zones immediately above the timber-line, upto an elevation of about 3700 m above mean sea level.

The type specimens are to be deposited in the collections of the Zoological Survey of India, Calcutta.

I offer my grateful thanks to Dr. M. S. Mani for guidance.

Family CHIRONOMIDAE**

Subfamily ORTHOCLADIINAE

Tribe Metriocnemini

Brillia kultia, sp. nov.

(Figs. 1A, 2A and 3A)

Male.—Yellowish-brown, legs and abdomen lighter in tone, head deep brown. Antennae plumose, with 14 segments, terminal segment longest, almost as long as the remaining segments combined; second antennal segment longer than the third and fourth segments combined. Eyes naked. Frons hairy. Palpi with 4 segments; terminal segment longer than third but shorter than second; second segment more than three times as long as the first. Thorax with dorsocentral hairs present. Pronotum makes a distinct collar. Legs slender; tibia longer than femur, spurs present; metatarsus nine-tenths the tibia and three-fourths the rest of the tarsus; third tarsal segment little less than twice as long as the terminal; pulvilli absent which according to Kieffer is well developed in the genus; empodius present, well developed and reaching the middle of the claws. Wings hairy, especially the apical one-fourth. Costa slightly produced; R_1 three-fourths as long as the R_{4+5}; r-m well developed rather straight; f.Cu somewhat beyond the meeting point of r-m and M; Cu_1 ends very much before the R_{4+5}; Cu_2 not bent distally. Abdomen yellowish-brown, slender. Genitalia with terminal clasp segment forked; basal segment with a spiny appendage near the distal end and another elongated club shaped appendage near the base; dorsal plate notched distally. Size 4.0 mm.

*Part XXVIII of this series is appearing in this Journal. Contribution No. 76 from the School of Entomology.

**Classification followed here is from Lindner, E. Die Fliegen der Palacarktischen Region, Stuttgart.

Holotype 1 male on slide. Collection No. 849/56. Kulti Nal, 3535 m; coll. R. L. Kotpal, 6. vi. 1956; from the surface of stagnant glacial pool. Station No. 30, cardex 160.

Paratype parts of one dissected male on the same slide as holotype with the same data.

This is the first record of the genus from the Indian faunal limits. The species reaches near *Brillia brevinervis* Kieff. in Geotghebuer's key[1], but can be readily distinguished in r-m being well developed, by the differences in antennal and leg ratios and in genitalia. A Palaearctic genus, with only 6 species so far known, is found in Central Europe, Corsica Islands, Siberia and Germany.

Metriocnemus (Heterotrissocladius) kuluensis, sp. nov.

(Figs. 1B, 1F, 2B and 3B)

Male.—Brownish-yellow, including legs and halteres. Head dark brown. Antennae with 14 segments, plumose; terminal segment longest, one and half times the remaining segments combined; first antennal segment globose basally and as long as the second and third segments combined. Eyes naked. Palpi with 4 segments; terminal segment longest and little less than twice the third; second segment equal to the third and thickened apically. Frons with a transeverse row of setae. Thorax brown; pronotum making a distinct collar; scutum without dorsocentral setae. Legs slender, tibial spurs present, hind tibia with a normal comb, half the length of the tarsus; metatarsus two-fifths of the tibia and half the rest of the tarsal segments combined; fourth segment as long as the terminal; pulvilli absent; empodium not well developed. Wings greyish, sparsely setose, setae generally confined to the apical part, rather more numerous along the anal angle. Costa not strongly produced; Sc reaching beyond r-m; R_1 half as long as R_{4+5}; tip of R_{2+3} nearer to the tip of R_1 than R_{4+5}; size and angle of r-m as shown in figure; f. Cu almost below r-m; Cu_2 curved distally. Abdomen moderately setose. Terminal clasp segment of genitalia blunt distally, with a pair of acute teeth; basal segment with an appendage in the middle on inner margin and another bifid appendage basally; dorsal plate acutely produced. Length 2·75 mm to 3·0 mm.

Female.—Colouration as in male. Antennae with 6 segments; terminal segment longest, longer than fourth and fifth together; second antennal segment as long as the following two; twice as long as thick and constricted in the middle. Palpi with 4 segments; terminal segment longest, more than one and a half times the third; second and third equal; first a little more than half the second. Wings as in male but more hairy. Abdomen comparatively more hairy than in male. Length 2·5 mm.

Holotype one male in spirit, *allotype* one female on slide. *Paratypes* 1 dissected male on slide, 3 males and 3 females in spirit (In author's collection). Collection No. 1004/56. River Beas near Rahla Forest Inspection Hut, 2700 m; coll. Santokh Singh, 20. vi. 1956, from stones overhanging the water. Station No. 10 and Cardex 212.

This species differs from the only other species of this genus so far known from India, *Metriocnemus callinotus* Kieff.[2] from Simla, in the venation, antennal and leg ratios and in the male genitalia.

1. Geotghebuer, M. 1940. Orthocladiinae in Lindner, E. Die Fliegen der Palaearktischen Region, 137 (13g):3.

2. Kieffer, J. J. 1911. *Rec. Indian Mus.*, 6:175.

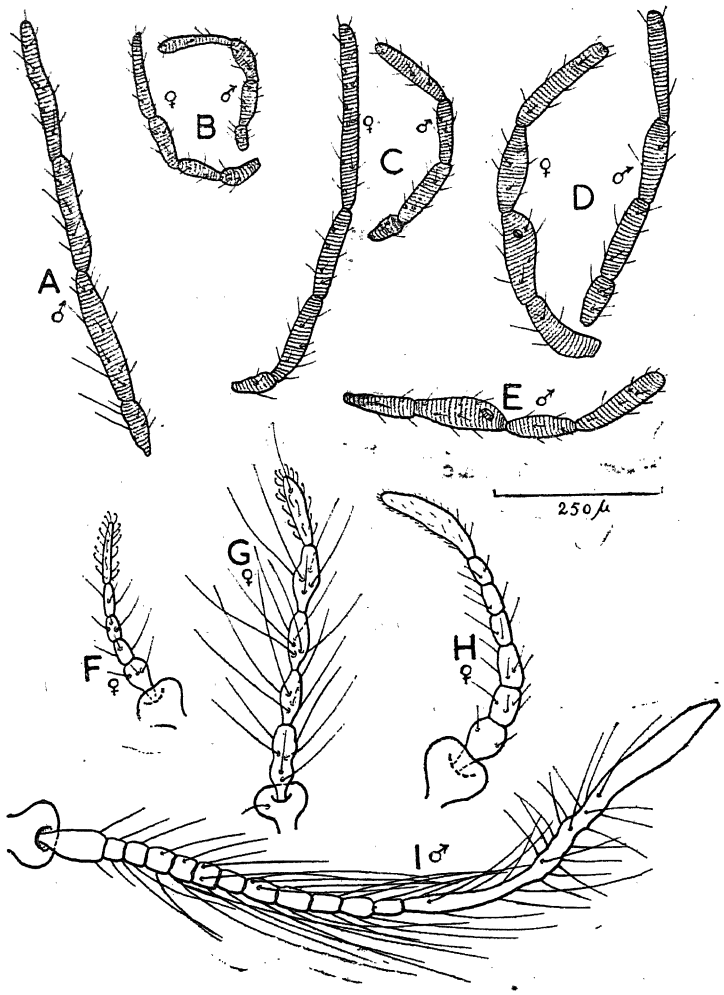

Fig. 1. Palpi of A. *Brillia kultia*, sp. nov., B. *Metriocnemus (Hetrotrissocladius) kuluensis*, sp. nov., D. *Orthocladius (Pseudorthocladius) virendri*, sp. nov. E *Trichocladius bryophila*, sp. nov., and antennae of F. *Metriocnemus (Heterotrissocladius) kuluensis*, G. *Metriocnemus (Heterotrissocladius) chandra*, H. *Orthocladius (Pseudorthocladius) virendri*, and I. *Trichocladius bryophila*.

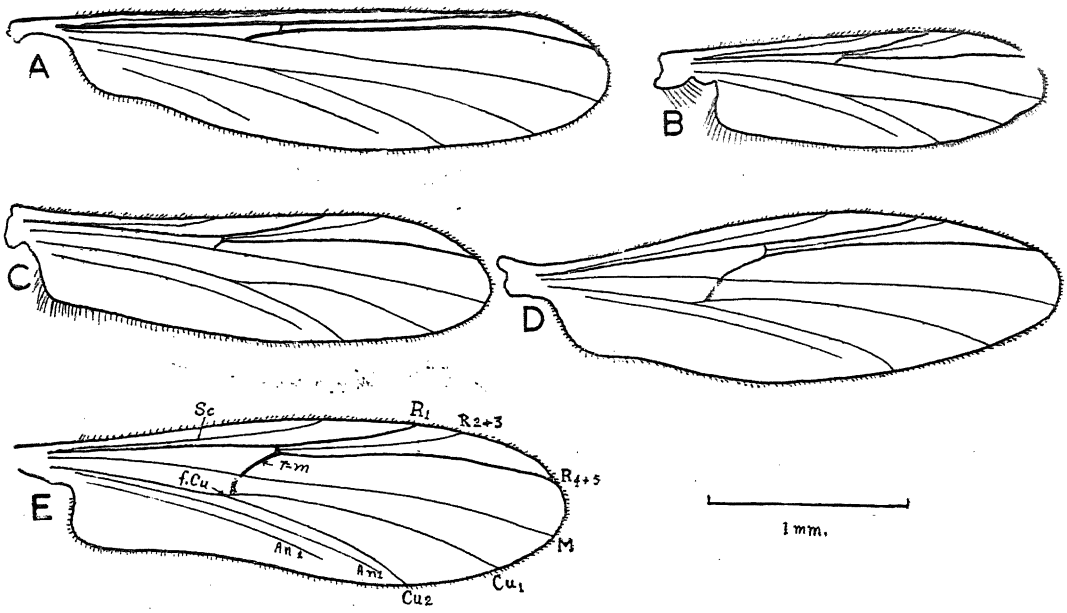

Fig. 2. Wings of A. *Brillia kultia*, B. *Metriocnemus (Heterotrissocladius) kuluensis*, C. *Metriocnemus (Heterotrissocladius) chandra*, D. *Orthocladius (Pseudorthocladius) virendri*, E. *Trichocladius bryophila*.

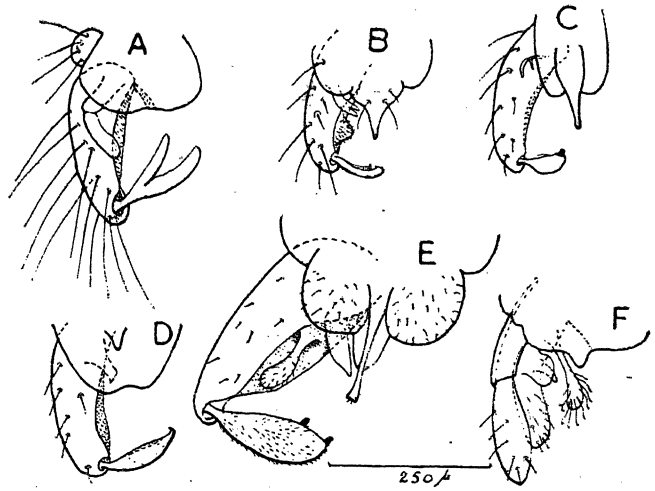

Fig. 3. Male genitalia of A. *Brillia kultia*, B. *Metriocnemus (Heterotrissocladius) kuluensis*, C. *Metriocnemus (Heterotrissocladius) chandra*, D. *Orthocladius (Pseudorthocladius) virendri*, E. *Trichocladius bryophila* and F. *Chironomus (Paratendipes) lahaulensis*.

Metriocnemus (Heterotrissocladius) chandra, sp. nov.

(Figs. 1C, 1G, 2C and 3C)

Male.—Yellow, abdomen deep yellow and tarsi brownish. Antennae with 14 segments, plumose; terminal segment lanceolate distally, longest, three-fourths the length of the rest of the segments combined; second antennal segment constricted and as long as the following two segments combined; third and fourth segments globular and remaining cylindrical. Eyes naked. Palpi with 4 segments; terminal segment longest, one and a half times the third; third and second equal; second thickened apically; first segment one-third of the terminal. Thorax naked. Pronotum making a distinct collar. Legs well developed; tibial spurs present, hind tibia with normal comb, tibia longer than metatarsus and half as long as the tarsus; metatarsus as long as the second and third tarsal segments combined; claws with a small obtuse tooth basally; pulvilli absent; empodium well developed. Wings sparsely setose; costa not produced; Sc just reaching the r-m; R_1 less than half as long as R_{4+5}; tip of R_{2+3} nearer to R_1; r-m rather oblique; f. Cu distal to the r-m; Cu_2 not conspicuously curved distally; R_{4+5} ends beyond Cu_1. Abdomen setose, slender. Terminal clasp segment of genitalia club shaped, with a well developed tooth distally; basal segment with a basal appendage; dorsal plate bilobed distally; dorsal spine well developed. Length 3·0 mm.

Female.—Colouration as in male. Antennae with 6 segments, terminal segment longest and a little less than fifth and fourth combined; third, fourth and fifth segments swollen in the middle; second antennal segment longer than third and slightly constricted in the middle. Palpi with 4 segments; terminal longest, more than twice as long as the third and second combined; first shortest and one-fourth the second. Wings as in male but heavily setose. Abdomen more hairy than in male. Length 2·75 mm.

Holotype 1 male, *allotype* 1 female on slide. Collection No. 78/55. Pir Panjal Range, opposite Kulti Nal, Chandra Valley (Lahaul), 3636 m; coll. Santokh Singh, 10. vi. 1955. *Paratypes* several examples. Station No. 26, cardex 73.

This species can readily be distinguished from *Metriocnemus (Heterotrissocladius) kuluensis*, by differences in antennal and leg ratios, wing venation, in the shape and proportion of female antennae and various differences in male genitalia.

Tribe Orthocladiini

Orthocladius (Pseudorthocladius) virendri, sp. nov.

(Figs. 1D, 1H, 2D and 3D)

Male.—Dark brown, legs slightly paler. Antennae with 14 segments, plumose; terminal segment longest, as long as the remaining segments combined; second antennal segment thickened distally, one and a half times as long as thick, one and a half times the second and third combined. Eyes naked. Palpi with 4 segments, terminal segment longest, one half of the remaining combined; second twice as long as the first and with a cup like sensory organ near the distal end. Pronotum making a distinct collar; dorsocentral hairs present. Scutum with long, well developed setae. Legs slender; tibia longer than femur, more than half as long as the tarsus; metatarsus seven-ninths of tibia; terminal tarsal segment longer than fourth and one-seventh the metarsus; hind leg fourth tarsal segment slightly swollen near the distal end; claws dentate; empodium well developed. Wings hairy; Costa produced beyond R_{4+5}; R_1 a little more than half of R_{4+5}; R_{2+3} ending nearer to R_1; r-m oblique; f. Cu beyond r-m; Cu_1 ending before R_{4+5}; Cu_2 curved apically; position of mCu cross vein with tracheal spiral. Genitalia very dark brown; basal segment with a simple appendage; terminal clasp segment ending in a curved tooth; dorsal plate notched posteriorly with a median spine basally. Length 3·25 mm.

Female.—Dark brown. Antennae with 8 segments; terminal segment longest, twice as long as the seventh and sixth combined; seventh shortest, less than one fourth the terminal; second antennal segment swollen distally, one and a half times the second. Palpi with 4 segments; terminal segment longest, one and a half times as long as the third; first and second equal; second swollen apically with a cup like sensory organ. Thorax with well developed dorsocentral hairs and scutum more hairy than in male. Length 4·0 mm.

Holotype 1 male, *allotype* 1 female, on slide. Collection No. 650/56. Chhatru, 3370 m; coll. V. K. Gupta, 14. vi. 1956. Station No. 51, cardex 195.

A North Palaearctic genus, which is being recorded here for the first time from the faunal limits of India, is disrributed in Siberia, Lappland, Spitzbergen and Greenland.

Trichocladius bryophila, sp. nov.

(Figs. 1E, 1I, 2 E and 3E)

Male.—Dark brown, legs of lighter shade. Eyes pubescent. Antennae with 14 segments, plumose; terminal segment longest, a little less than the rest of the segments combined; second antennal segment thickened distally, twice as long as thick and longer than the following two combined. Palpi with 4 segments; terminal longest and a little less than twice the third; second slightly curved and thickened apically with a cup like sensory organ, and twice as long as the first. Thorax with dorsocentral hairs. Legs slender; tibia as long as femur; metatarsus shorter than tibia and about three-fourths the latter, and as long as the rest of the tarsus; fourth shortest; fifth one half times the fourth; empodium well developed. Hind tibial comb normal, tibial spur spiny. Wings with costa produced beyond R_{4+5}; R_{4+5} twice the R_1; R_{2+3} nearer to R_1; r-m oblique; f.Cu before r-m; Cu_1 ends before R_{4+5}; Cu_2 almost straight; anals present and reaching beyond f.Cu. Abdomen brown, hairy. Genitalia dark brown; terminal clasp segment club shaped with a pair of obtuse teeth at the tip but separated from each other; basal segment with a spiny distal appendage and another simple pointed proximal appendage; dorsal plate with two spiny lateral lobes and a blunt median spine reaching the middle of the basal clasp segment. Length 3·25 mm.

Holotype 1 male on slide. Collection No. 9/55. Rahla, 2700 metres; coll. Santokh Singh, 25. v. 1955. Station No. 8, cardex 12. Collected from moist rock covered with moss.

So far only two species *Trichocladius spatulicornis* Kieff. and *T. anomalus* Kieff.[3] are recorded from India, the present species approximates the latter but it can be readily distinguished by its dark brown colour, differences in antennal and leg ratios, wing venation and various differences in the male genitalia.

Subfamily Chironominae

Chironomus (Paratendipes) lahaulensis, sp. nov.

(Fig. 3F)

Male.—Black. Body and legs stout; abdomen hairy. Eyes naked. Proboscis hairy. Antennae with 14 segments, plumose, terminal segment longest, one and a half times the remaining segments combined; second antennal segment nearly twice as long as thick, almost as long as the following two segments combined. Palpi 4 segments; terminal segment as long as the second; first shortest, twice as long as

3. Kieffer, J. J. 1911. *Rec. Indian Mus.*, 6 : 177.
Kieffer, J. J. 1913. *Rec. Indian Mus.*, 9 : 124.

thick and a little more than one fourth the second. Pronotum fairly well developed but not distinctly divided in the middle. Legs dark brown, stout; tibia as long as the metatarsus and two-fifths of the tarsus; terminal segment shortest; pulvilli absent, tibial comb normal. Wings naked; costa fringed, ends abruptly very much before the apex; Sc. reaching beyond r-m but not meeting C.; R_1 ending a little beyond half of R_{4+5}; R_{2+3} nearer to R_1; R_1 with stout setae; R_{4+5} with scanty setae especially near the tip; r-m straight and well developed. M ending very much beyond C and R_{4+5}; f. Cu a little before r-m; Cu_1 ending very much before M and R_{4+5}; Cu_2 curved upwards near the margin; An_1 reaching much beyond f. Cu but not meeting the margin; An_2 reaches just beyond f. Cu. Abdomen black, hairy. Genitalia with terminal clasp segment blunt and hairy, basal appendage club shaped with curved setae as in figure 3F; dorsal plate produced into an obtuse point posteriorly. Length 4·5 — 5·5 mm.

Holotype 1 male in spirit, *paratypes* 2 males dissected on slides and several examples in spirit. Collection No. 942/56. Stream about 3 kilometres up the Kulti Nal from the R. Chandra, on the right bank of the Nal, 3636 m; collected Santokh Singh, 6. vi. 1956. Station No. 48 and cardex 161. Collected from stones covered by thick growth of algae.

This species may readily be distinguished from other *Chironomus* species from India by its well marked characters of antennal and palpal ratios and genital armature.

EFFECT OF VITAMINS AND HORMONES ON THE GROWTH OF PESTALOTIA MALORUM AND PESTALOTIA PSIDII

By
M. P. TANDON
(Department of Botany, University of Allahabad)
Received on 18th February 1958

INTRODUCTION

Growth promoting substances have been found necessary for the development of certain fungi. Willaman (1920), observed that *Sclerotinia cinerea* required an accessory material similar to vitamin B. Farries and Bell (1930), found that while many fungi grew on simplified Brown's medium *Nematospora, coryli, N. Gossypii* and *Spermophthora gossypii* required, in addition, some active accessory material which was apparently present as an impurity in various natural protein sources. Marloth (1931) reported that growth of *Penicillium digitatum* was markedly accelerated by addition of a small amount of organic juice to synthetic media. He suggested that for suitable growth the fungus required a Vitamin occuring in citrus fruits. Ezekiel *et al.*, (1934) found that small quantities of carrot juice added to synthetic media resulted in disproportionately large increases in growth of the fungus, and suggested that some growth promoting material was involved.

Schopfer (1938) observed that *Phycomyces blakesleeanus* could not grow on pure synthetic media, but that organic material such as yeast, wheat or green leaf extract must be added. Schopfer (1938) and independently Burgeff (1934) tried crystelline thiamine and found it highly active as it supported excellent growth of *Phycomyces.*

Investigations of Hawker (1936), Leonian and Lilly (1937, 40), Robbins and Kavanaugh (1938*a*, *b*) Schopfer (1934, 36), Schopfer and Blumer (1938), Kogl and Fries (1937) as well as several others had demonstrated the importance of growth promoting substances for the nutrition of various fungi investigated by them. The fungi that have been mostly studied belonged to the genera *Aspergillus, Penicillium, Rhizopus, Phytophthora, Pythium,* and *Melanospora.* A review of the existing literature however indicated that the genera *Pestalotia* had received no attention so far. It was, therefore, decided to investigate the effect of some of the growth promoting substances on the growth of *P. malorum* and *P. Psidii.*

MATERIAL AND METHODS

The material used consisted of pure cultures of *P. malorum* and *P. psidii* maintained on oat meal agar and isolated from rotten hill apples and mummified fruits of guavas respectively.

Asthana and Hawker's medium A, was selected as contol. To this medium the Vitamins-thiamin, nicotinic acid and ascorbic acid were added singly, so as to provide 10, 20, 30 or 40 international unit per 100 c. c. of the solution. Lentil extract another growth promoting substance was used at the concentration of 0·2%, 0·4%, 0·6% and 0·8%. Growth harmones chlorophenoxy acetic acid, Indole 3-acetic acid and indole-propionic acid were added singly to the basal medium in concentrations of 0·001%, 0·0001%, and 0·00001%. Both Vitamins and harmones were added after the sterilization of the basal medium.

Throughout the investigation only pyrex glass wares, double distilled water and as far as possible chemicals of analytical grade or purest available were used.

In a 150 c. c. Erlenmeyer flask 50 c. c. of the nutrient solution was taken and sterilized in an autoclave at 15 lbs. pressure for 15 mts. Four replicates were used for each series. The method of inoculation, incubation, filteration, dehydration and weighing were similar to those described by Tandon (1950). Inoculated cultures were incubated at 18-20°C for 14 days.

Some macroscopic as well as microscopic studies were also undertaken to study the effect of growth promoting substances on the morphology of the organisms.

OBSERVATIONS

The dry weight of the organisms obtained at various concentrations of several growth promoting substances are given in Table I. In the absence of any marked difference in the individual replicates only the average weight was recorded. The results were compared from the standard medium (or control) which consisted of Asthana and Hawker's medium A.

TABLE I

Gives dry weight of Pestalotia spp. on different concentration of various growth promoting substances after 14 days incubation at 18-20°C.

Growth promoting substance	Concentration per 100 c.c. of solution	Average yield in gms. of *P. malorum*	Average yield in gms. of *P. Psidii*
Thiamin	10 I. U.	0·2612	0·2568
	20 I. U.	0·2703	0·2625
	30 I. U.	0·2856	0·2722
	40 I. U.	0·2637	0·2534
Nicotinic acid	10 I. U.	0·2250	0·2169
	20 I. U.	0·2189	0·2083
	30 I. U.	0·2100	0·2067
	40 I. U.	0·2056	0·2032
Ascorbic acid	10 I. U.	0·2066	0·2024
	20 I. U.	0·2059	0·2018
	30 I. U.	0·2030	0·2009
	40 I. U.	0·1951	0·1934
Lentil extract	0·1	0·2617	0·2487
	0·4	0·2714	0·2555
	0·6	0·2825	0·2612
	0·8	0·3012	0·2864
Chloro-phenoxy acetic acid ...	0·00001	0·2600	0·2491
	0·0001	0·2870	0·2570
	0·001	0·2384	0·2180
Indole—3—acetic acid ...	0·00001	0·3130	0·2678
	0·0001	0·2946	0·2406
	0·001	0·2088	0·2031
Indole-propionic acid ...	0·00001	0·2840	0·2712
	0·0001	0·3205	0·3160
	0·001	0·3470	0·2215
Control	...	0·2570	0·2482

It would be observed from the above table that the action of the growth promoting substances was not uniform. While nicotinic and ascorbic acids inihibited the growth, the other growth promoting substances at certain concentrations exhibited definite improvement. Addition of thiamin increased yield of the two fungi, and best results were obtained when it was used at concentrations of 20 or 30 I. U. per 100 c.c. of solution. As regards *P. malorum*, it was observed that its growth improved with increase in the concentration of Lentil extract or indole-propionic acid. *P. Psidii* also recorded gradual increase in its dry weight, with larger quantities of lentil extract. In all other cases, there was some improvement in growth or yield at lower concentrations, but adverse effect was noticed where the concentration was increased beyond a certain point. The concentrations tolerated by the two organisms varied with the nature of the growth promoting substance.

The macroscopic as well as microscopic study revealed that morphological characters were unaffected by the addition of growth promoting substances. The growth in every case was quite normal. The mycelial development and sporulation remained unaffected by the addition of growth promoting substances.

DISCUSSION

Growth promoting substances have long been known to play an important role in the nutrition of fungi. So far, researches were mainly confined to yeast, *Aspergillus*, *Rhizopus*, *Melanospora* etc. But *Pestalotia* remained unstudied. The investigations with *P. malorum* and *P. psidii* confirmed the observations of previous investigators regarding the importance of these substances in the nutrition of fungi.

Both *P. malorum* and *P. psidii* responded favourably when thiamin was provided in proper concentrations. Increased growth in presence of thiamin had been reported for several fungi by Kogl and Fries (1937), Robbins and Kavanaugh (1938), Leonian and Lilly (1938), Schopfer (1938), Quantz (1943), Noecker and Reed (1943), Fries (1943, 50) Saksena (1943), Tanaka and Katsuki (1953), and Morton and Stroube (1955).

An addition of nicotinic or ascorbic acids to the nutrient media decreased the growth of *P. malorum* and *P. psidii*. It was further noted that at higher concentrations of these substances the inhibition was more pronounced. It was, therefore, concluded that both these substances were unfavourable for the growth of *P. malorum* and *P. psidii* Burkholder and Moyer (1943) working on a number of yeast and moulds reported that most of the fungi needed nicotinic acid for their growth, while ascorbic acid was considered unimportant by them. Clark *et al.* (1948) also observed nicotinic acid to be necessary for *Schizosaccharomyces pombe* Villela and Cury (1950) found that nicotinic acid stimulated growth of *Allescheria boydii*. Thus, *P. malorum* and *P. psidii* differed from other fungi in their response towards nicotinic acid.

Lentil extract was known to contain several important growth promoting substances like biotin, and inositol etc. In the present investigation it was observed that its addition to the nutrient medium brought about an increase in the yield of both the organisms. The yield continued to increase with an increase in the concentration of the lentil extract. Williams and Rohrman (1936), Hawker (1936), Kogl and Tonnis (1936) Steinberg (1939), Barnett and Lilly (1948), Clark *et al.* (1948) had also reported about the beneficial effect of inositol on the growth of the fungi investigated by them. Similarly, the need of biotin for the nutrition of various fungi had been observed by Kogl and Tonnis (1936) Kogl and Fries (1937), Fries (1943), Clark *et al.* (1948) Barnett and Lilly (1948) Marsh *et al.* (1946) and Tanaka and Katsuki (1953).

Most of the previous investigators confined themselves to the study of growth promoting substances consisting of vitamins. Little attention was paid to the plant harmones which have been observed to be useful for higher plants. The present investigation showed that their addition in low concentrations increased the growth of the organisms. At higher concentrations, however, they exerted an inhibitory effect except for indole propionic acid which appeared beneficial for *P. malorum* even at a concentration of ·001%. Leonian and Lilly (1937) observed that β-indolyc acetic acid when used in higher concentration proved toxic and in lower concentrations it failed to induce stimulation in the growth of the fungi on which they worked, a-napthelene acetic acid was observed by Wolf (1937) to cause inhibition of the growth in *Saprolegnia ferax* and *Achlya bisexualis*. Murdia (1939), working on some members of family *Saprolegni aceae* observed that β-indolyl-acetic acid and phenyl acetic acid were useless in their nutrition. Indole-3-acetic acid or 'auxin' accelerated the growth of both *P. malorum* and *P. psidii*. Nielsen (1930) had also reported that at low concentrations it proved useful for *A. niger*.

Growth promoting substances used in the present investigation appeared to have no influence on the morphology of the organisms. A study of the microscopic and macroscopic characters revealed that on the addition of growth promoting substances the character of mycelium and spores was not modified.

SUMMARY

The action of the growth promoting substances was not uniform. Nicotinic and ascorbic acids inhibited the growth. Addition of thiamin increased yield of the two fungi. Best results were obtained when thiamin was added at a concentration of 20 or 30 I. U. per 100 c. c. of the solution.

Growth of *P. malorum* improved with an increase in the concentration of lentil extract or indole-propionic acid. *P. psidii* responded similarly when lentil extract was added to its nutrient medium, but indole-propionic acid was best utilized by it only when added at a concentration of 0·0001%. Lower concentrations also supported good growth but at higher concentrations the growth was unsatisfactory. Addition of indole-3-acetic acid in low concentrations to the nutrient media improved growth of both the fungi, but its higher concentrations were found unfavourable. Chloro-phenoxy,-acetic acid was best utilised by both *P. malorum* and *P. psidii* when used at a concentration of 0·0001%. Its use in higher or lower doses was not so favourable.

A study of the macroscopic characters revealed that on the addition of growth promoting substances the character of mycelium and spore was not modified.

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*Originals not seen.

ENTOMOLOGICAL SURVEY OF THE HIMALAYA

PART XXIII.—STONEFLIES (PLECOPTERA) FROM THE NORTH-WEST (PUNJAB) HIMALAYA*

By

STANLEY G. JEWETT, Jr.,

7742 S. E. 27th Avenue, Portland 2, Oregon, U. S. A.

Received on 18th August, 1958

Among the interesting insects collected by Prof. Mani's Second Entomological Expedition to the North-West Himalaya from the School of Entomology, St. John's College, Agra, are a number of stoneflies, nymphs as well as adults. This material, taken at high elevations, is of very great value because it contains genera not before reported from the North-West Himalaya. Kimmins (1946) described a number of stoneflies from the vicinity of Mount Everest and from Sikkim, some (600 to 700 miles) to the east of Lahaul-Spiti, the region from which the present collection was made. It is of interest to note that only one of his species, *Rhabdiopteryx lunata,* is included in the present material. Needham (1909) described five holognathous stoneflies from Kulu, but none of these is in the present collection, unless represented by two immature perlodid nymphs from Rahla that cannot be placed to genus with certainty.

In their most interesting ecological account of the insects at high elevations in the North-West Himalaya, Mani and Singh (1955) and Singh (1958) record the relative abundance of various orders of insects, including Plecoptera, at different altitudinal zones. Their paper also includes precise descriptions of the stations where collections of insects were made by the Second Entomological Expedition.

The holotypes and allotypes of all species described in this paper are to be deposited in the Zoological Survey of India, Calcutta. Some of the paratypes and other specimens are in the writer's collection (SGJ, Jr).

NEMOURIDAE

TAENIOPTERYGINAE

1. Rhabdiopteryx lunata Kimmins

1946. *Rhabdiopteryx lunata* Kimmins, pp. 722-724.

The material listed below agrees generally with the original description of this species. The clear band in the fore wing is not always present, particularly in specimens collected at elevations under 14,500 feet. A male specimen from Chhatru is unusually large with a body length of 12 mm. and the band on the fore wing is brownish fuscous instead of being clear; however, the genitalia seem to be identical with the other males.

Material examined: Kulti Nal, 11,600 ft., Chandra Valley, (Santokh Singh) 9-VI-55,/male; Chhatru, 11,500 ft., Chandra Valley, (Santokh Singh), 15-VI-55, 6 females (3 females, SGJ, Jr); Chhatru, 11,000 ft., Lahaul-Spiti, 15 VI-55 (A. P. Kapur), 2 males, 2 females (1 male, SGJ. Jr); Hamta Jot, 14,500 ft., 16-VI-55, (Santokh Singh), 3 males, 2 females, (1 male, 1 female, SGJ, Jr).

*The stoneflies collected by the Third Entomological Expedition to North-West Himalaya are also in the hands of Dr. Jewett for study, and a report will follow.

LEUCTRINAE

2. **Leuctra (Rhopalopsole) magnicerca** Jewett, new species

Length to wing tips: holotype male, about 7 mm. Length of body: holotype male, about 6·5 mm.

General color of holotype male, which is in poor condition, light brown. Greatest width of pronotum about fifth less than width of head through compound eyes. Rear ocelli about twice as far apart than is either to compound eye; distance between anterior ocellus and either rear ocellus not quite as great as distance between rear ocelli. Pronotum slightly longer than wide, borders all quite straight, angles only slightly rounded, shield with dark brown median line on either side of which is stripe of yellow bordering broader stripe, enclosing few embossings against yellow background; dark brown line borders entire pigmented area which is somewhat rectangular with widely rounded corners on either side. Fore wings of holotype missing, hind wings hyaline with normal venation. Abdomen in poor condition, but apparently first eight tergites without special structures. Ninth sternite with lobe at base. Posterior median portion of tenth tergite formed into small, heavily sclerotized, forward-directed hook. Lateral portion of tenth tergite enlarged and drawn out to form broad, slightly bent point. Cerci beset with hairs and with very large, truncately rounded tips, arise from base of tenth tergite (fig. 1A). The drawn out portion of lateral sclerite of tenth tergite appears to be part of the cercus.

Holotype, male; Kote, 8,000 ft., Kulu Valley, 20-VI-55, A. P. Kapur.

This new species is allied to other Asiatic leuctrines which were originally described in the genus *Rhopalopsole*. As noted elsewhere (Jewett, in press), *Rhopalopsole* is regarded as a subgenus of *Leuctra*. The present species differs from others in the group principally in the shape of the lateral sclerite of the tenth tergite and in the size and shape of the cerci.

CAPNIINAE

3. **Capnia manii** Jewett, new species

Length to wing tips; male, 8-9 mm.; female, 9-9·5 mm. Length of body: male, 7-8 mm.; female, 8-8·5 mm.

General color dark brown to black. Head through compound eyes as wide as greatest width of pronotum; lateral ocelli closer to compound eyes than to each other; three ocelli forming equilateral triangle. Pronotum slightly wider than long, widest rearward, all angles rounded, very densely pigmented. Venation of wings typical for genus, fore wings irregularly banded with hyaline, distal margin bordering wide dusky band, in turn bordering an irregular light band in region of cord; hind wings largely hyaline.

Male—First eight abdominal segments without special structures; ninth sternite with vestigial lobe at base. Subanal lobes well sclerotized, truncate distally. Ninth tergite with median low hump at posterior margin. Anterior margin of tergites six through nine with widely rounded, median excision in sclerotized part of each tergite, leaving membranous area, rounded on tergite six, almost V-shaped on tergite nine (fig. 2). Supra-anal process of tenth tergite long, narrow V in dorsal view, with median transluscent area extending from base to tip; in lateral view (fig. 2A) thickened to depth at least equal to half width in dorsal view. Cerci long, many-segmented.

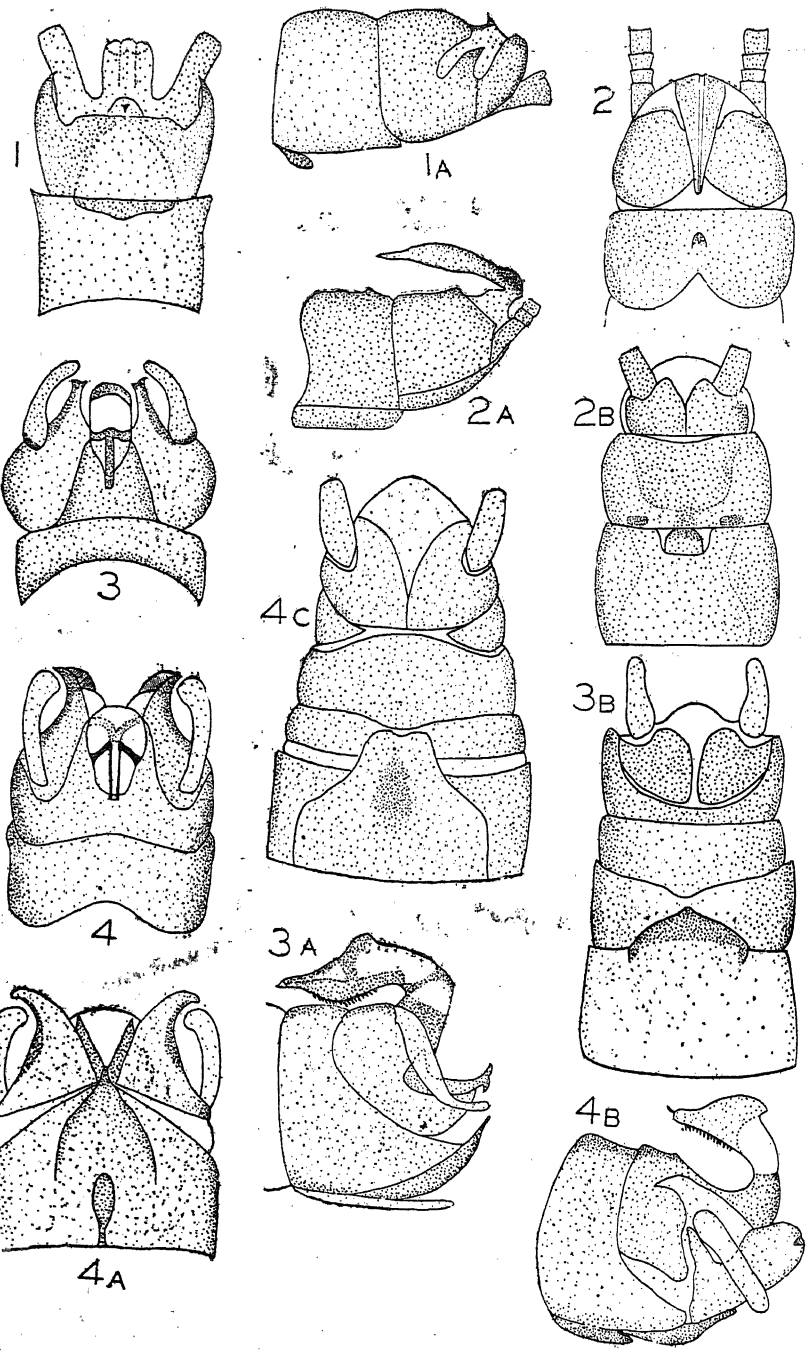

Fig. 1

Female—Posterior margin of eighth abdominal sternite with median, rectangular notch that occupies nearly third of width of sternite and extends forward almost third of depth of sternite (fig. 2B). In depression beneath rectangular notch is rather heavily pigmented area. Ninth abdominal sternite sclerotized as in fig. 2B, with median, rectangular area opposite median sclerotized area on eighth tergite. Broad median membranous stripe extends horizontally across tergites one through eight.

Holotype male, *allotype* female, three males and three females *paratypes*; River Beas Valley near Marhi, 11,000 ft., 31-V-55, Santokh Singh (2 males and 2 females paratypes, SGJ, Jr). Additional paratypes as follows; Marhi, 12,000 ft., 1-VI-55, V. K. Gupta, two males, 1 female.

The lack of a developed ventral lobe and the shape of the supra-anal process distinguish the male of this species from the described species of *Capnia*. The sclerotization of the seventh and eighth female sternites is distinctive but bears some likeness to that of *C. montana* Kimmins from Sikkim.

Nearly mature nymphs of *Capnia*, very possibly of this species, and a single nymph of a second species, were taken from the Beas River one mile south of Rohtang Pass at 11,000 ft., 20-VI-55, by A. P. Kapur. Another nymph, tentatively identified as *C. manii*, from the Beas River at Rahla was taken 27-VI-55 by A. P. Kapur.

NEMOURINAE

4. Nemoura (Nemoura) ampula Jewett, new species

Length to wing tips: male holotype, 6·5 mm.; female, 8 mm. Length of body: male holotype, 5·5 mm.; female, 7 mm.

General color light brown with mottled wings and legs. No external gills. Head wider than pronotum, much wider than long, dark throughout except for light patches on clypeus. Pronotum about as wide as long, front angles rounded sharply, hind angles rounded broadly so that sides narrow posteriorly. Antennae many-segmented, in length equal to length of body. Large, irregular, dusky patches on fore wing especially on outer half, loosely arranged in three rows; hind wings hyaline except for some darkening in costal area near transverse cross vein. Wings appear to be slightly brachypterous. Femora with four irregular bands, basally yellow, ill-defined, narrow band followed by darker band, yellow band, and distally a dusky band; tibiae with three bands, central yellow band, bordered by two wider, dusky bands.

Male—Abdominal segments light brown, progressively more sclerotized rearward. Ninth tergite narrow, lightly sclerotized; ninth sternite greatly produced behind and with lobe twice as long as its greatest width, median plate terminating in dully pointed tip. Cerci long, membranous, bearing hairs, and in lateral view weakly S-shaped (fig. 3A). Supra-anal process recurved, from above with straight sides sloping distally to rounded, narrow tip, on lower edge beset with teeth-like setae, sclerotized as in fings. 3 and 3B. Subanal lobes membranous and somewhat truncate basally, with upturned, heavily-sclerotized portion that terminates in furcate tip with two sharp points.

Female—In general features similar to the male. Cerci little modified, curved slightly inward. First six sternites largely membranous when cleared. Seventh sternite membranous except for large median sclerotized plate, sides of which slope inward to from blunt tip, plate extending distance equal to about third of length of

sides of seventh sternite; eighth sternite sclerotized on either side and rather narrow; ninth sternite largely sclerotized, median area extending rearward to overlap posterior part of eighth sternite; tenth sternite and appendages sclerotized.

Holotype male, *allotype* female, and one *paratype* female: Beas River at Rahla, Station 4, 27-V-55, A. P. Kapur. Paratype in writer's collection.

In the sclerotization of the male supra-anal process and the shape of the male cerci this species differs from other described members of the subgenus *Nemoura*.

A number of nymphs from the Beas River at Rahla and from near the source of the Beas River at an elevation of about 11,000 feet appear to belong to this species.

5. **Nemoura (Nemoura) cordata** Jewett, new species

Length to wing tips: male, 9·5-10·5 mm.; female, 10·5-12 mm. Length of body: male, 6·5-8 mm.; female, 7·5-9 mm.

General color brown, with mottled wings and legs very similar to those of *N. ampula*, but with darker pigmentation. No external gills. Head and pronotum similar in color and shape to those of *N. ampula*, but with only very limited light area on median outer edge of clypeus. Dusky mottling of fore wing occupies over half of wing area leaving irregularly-shaped, clear spots; hind wing with outermost cells beyond cord with some dusky pigmentation, rest of wing clear. Femora and tibiae each with three bands, a central yellow band bordered with wider dusky bands, bands not sharply delimited.

Male—Abdominal segments light brown, progressively more sclerotized rearward. Ninth tergite narrow; ninth sternite greatly produced behind and with lobe twice as long as greatest width, median plate tapering to blunt tip (fig. 4A). Cerci long, lightly sclerotized, bearing hairs, turned slightly inward from dorsal view, but little curved in lateral view, fairly uniform in thickness through their length, slightly enlarged at fully rounded tips. Supra-anal process recurved, from above heart-shaped, with short bifid tip which is upturned hook in lateral view, lower edge smooth, sclerotized as in figs. 4 and 4B. Subanal lobes truncate basally with large sclerotized process curving upward and outward to form large hooked tip.

Female—In general features similar to the male. Cerci little modified. First six abdominal segments membranous when cleared; seventh sternite membranous except for large subgenital plate that extends rearward for distance equal to about third of length of sides of seventh sternite proper, tip broadly truncate, border slightly recessed in middle; scleroitized eighth sternite narrow; sclerotized ninth sternite centrally produced backward to cover part of eighth; tenth sternite, subanal lobes and cerci sclerotized.

Holotype male, *allotype* female, and two *paratype* females: Gramphu, Lahaul-Spiti 11,000 ft., 18-VI-55, A. P. Kapur. One paratype in writer's collection. Paratypes as follows: Chandra Valley, 12,000 ft.; 10-VI-55, H. N. Baijal, one male (SGJ, Jr). Gramphu, 12,000 ft., 10-VI-55, (V. K. Gupta), one female.

This species is close to *N. ampula*, but the details of the genitalia of both sexes easily separate it.

6. **Nemoura (Nemoura) punctata** Jewett, new species

Length to wing tips: male, 9·5-10 mm.; female allotype, 12 mm. Length of body: male, 6 mm.; female allotype, 8 mm.

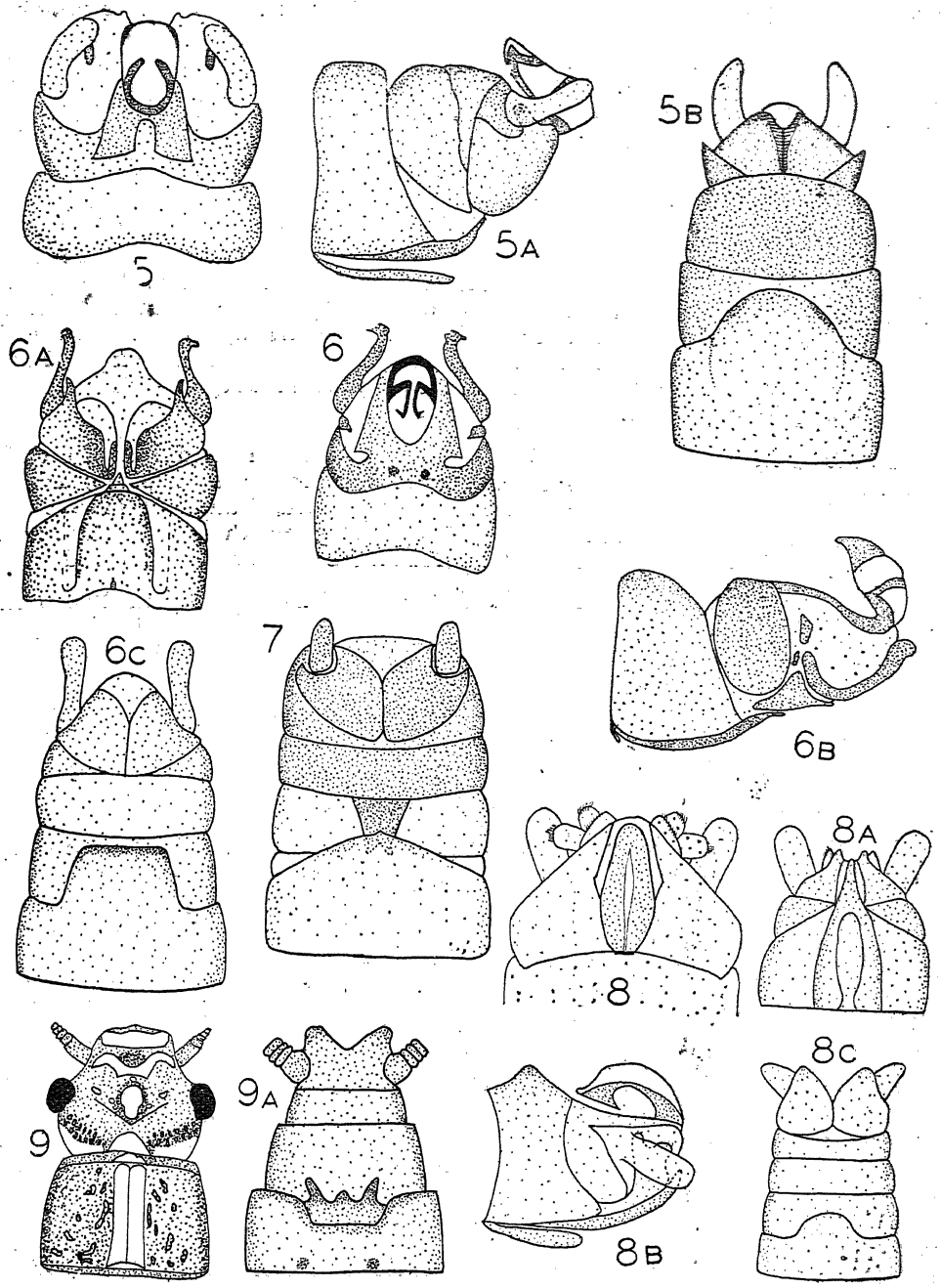

Fig 2

General color light brown with speckled wings and banded legs. No external gills. Head and pronotum similar in shape to those of *N. ampula* and *N. cordata* but lighter in color, the anterior outer corners of pronotum light brown, clypeus bordered by yellow band. Fore wing with many irregular dusky spots throughout, not formed into bands; hind wings clear except in stigmal area where irregular dusky spots occur. Femora with basal yellow band for at least half length, remaining area dusky except for terminal yellow band; tibiae with dark basal band occupying about quarter of entire length, followed by sharply delimited yellow band that blends gradually to a brownish yellow distal area.

Male—Abdominal segments light brown, progressively more sclerotized rearward. Ninth tergite normal in width; ninth sternite greatly produced behind and with lobe twice as long as greatest width, median plate tapering to sharp point, otherwise similar to that of *N. cordata*. Cerci slightly elongated, turned inward, bearing hairs. Supra-anal process recurved, from above, fig. 5, oval in shape with broad rounded tip, lower edge beset with fine spinules, sclerotized as in figs. 5 and 5A. Subanal lobes from below somewhat triangular in shape with broad base, upturned lobe terminates in finger-like process.

Female—In general features similar to male. Cerci little modified. First six segments of abdomen membranous; seventh sternite membranous except for evenly rounded, sclerotized subgenital plate that extends rearward distance equal to about half of length of sides of seventh sternite proper, fig. 5B; eighth sternite sclerotized heavily only on sides; ninth, tenth sternites, subanal lobes, and cerci sclerotized.

Holotype male, *allotype* female, and two *paratype* males: Gramphu, 12,000 ft., 8-VI-55, H. N. Baijal. One paratype in writer's collection. An additional female paratype: River Beas Valley near Marhi, 11,000 ft., 31-V-55, (Santokh Singh) (SGJ, JR).

Allied to the foregoing two species *N. punctata* differs in the speckled wings and in details of the genitalia of both sexes.

7. **Nemoura (Nemoura) punjabensis** Jewett, new species

Length to wing tips: male, 6·5-7 mm.; female, 7-8 mm. Length of body: male, 5 mm.; female, 6 mm.

General color light brown, with brown legs and wings that are irregularly banded. No external gills. Head distinctly wider than pronotum, dark brown including clypeus. Pronotum wider than long, sides rather straight, hind angles more rounded than anterior ones. Fore wings with three light bands between dusky ones; hind wings hyaline except for very narrow dusky band bordering outer tip. Legs brown, not banded.

Male—Abdominal segments brown, lightly sclerotized to tenth segment, which with its appendges is more heavily sclerotized. Ninth sternite moderately produced behind and with only vestigial lobe, median plate produced and with small conical tip, (fig. 6A). Cerci heavily sclerotized, long, narrow, with outwardly-directed, rather sharp tips. Supra-anal process recurved, from above oval in shape, laterally with downward-directed tip, lower surface smooth (figs. 6 and 6B). Tenth tergite with pair of median, slightly raised scabrous areas. Subanal lobes with sclerotized basal plate, outer corners of which are drawn out to thumb-like tips, inside median borders of which are elongated, rectangular, membranous areas (fig. 6A).

Female—In general features similar to male. Cerci somewhat elongated but otherwise unmodified. First six abdominal segments membranous, terminal four

lightly sclerotized when cleared. Subgenital plate on seventh sternite rectangular in shape with broad truncate tip (fig. 6C) and extends rearward distance about equal to length of sides of seventh sternite proper.

Holotype male, *allotype* female, six males and 11 females *paratypes*: Chhatru, Lahaul Spiti 11,000 ft., 15-VI-55, A. P. Kapur. Two males and two female paratypes in writer's collection. Additional paratypes as follows: Rahla, 9,000 ft., 26-V-55, H. N. Baijal, 2 males, 2 females (SGR, Jr); same except collected by V. K. Gupta, 2 males, 1 female; same except 8,835 ft., 29-V-55, Santokh Singh, 1 female; 2 miles south of Rahla, 10-11,000 ft., 26-V-55, A. P. Kapur, 4 males, 1 female; Chhatru, bank of Chandra, 11,000 ft., 16-VI-55, A. P. Kapur, 1 male, 3 females; Chhatru, 12,000 ft., 16-VI-55, V. K. Gupta, 5 males, 1 female (2 males, 1 female (SGJ, Jr); Kulti Nal, Chandra Valley, 11,600 ft., 7-VI-55, Santokh Singh, 1 male; Chandra Valley, 12,000 ft., 10-VI-55, H. N. Baijal, 1 female; Gramphu, 12,000 ft., 7-VI-55, H. N. Baijal, 2 females; Dhorni, Chandra Valley, 12,000 ft., 13-VI-55, Santokh Singh, 1 male, 2 females; River Beas Valley near Marhi, 11,000 ft., 31-V-55, Santokh Singh, 2 females; Pir Panjal Range opposite Kulti Nal, 12,000 ft., 10-VI-55, Santokh Singh, 3 males, 1 females; on snow between Chhatru and Gramphu, 11-12,000 ft., 18-VI-55, A. P. Kapur, 1 female; Rohtang Pass, 13,000 ft., on snow, 19-VI-55, A. P. Kapur, 1 male; Beas River near Rahla, 8,830 ft., 26-V-55, A. P. Kapur, 3 males, 3 females (SGJ, Jr).

Nemoura rahlae Jewett, new species

Length to wing tips: holotype female, 13·5 mm. Length of body: holotype female, 9·5 mm.

General color of holotype brown, with fumose wings and unbanded brown legs. No external gills. Head wider than pronotum, dark brown. Pronotum light brown with straight sides narrowing posteriorly, surface rugose, wider than long. Fore wings generally fumose, little lighter in medio-cubital area, hind wings uniformly, fumose brown. First eight abdominal segments largely membranous, last two, together with appendages of tenth, heavily sclerotized. Subgentital plate on seventh sternite tapering evenly to tip, produced distance equal to about half length of sides of sternite proper. Eighth sternite with heavily sclerotized median plate as in fig. 7.

Holotype female: Rahla, 8,835 ft, 25-V-55, V. K. Gupta.

The holotype is not in good condition, and it is possible that additional material will show that there all cervical gills in this species which is not now placed in a subgenus.

9. **Nemoura (Amphinemura) tricantha** Jewett, new species

Length to wing tips: male, 7 mm; female, 7 mm. Length of body: male, 5·5 mm.; female, 5·5 mm.

General color light yellow brown, with hyaline wings and brownish-yellow legs. Typical cervical gill tufts present. Head much wider than pronotum, light brown in color. Prothorax slightly wider than long, anterior angles rounded more than those at rear, brown with darker brown rugosities.

Male—Abdominal segments light brown, tenth and appendages yellow. Ninth tergite normal; ninth sternite produced rearward with lobe three times as long as greatest width, median plate elongate and terminating in long, blunt tip (fig. 8A).

Cerci membranous, plump, bearing hairs and turned slightly outward. Supra-anal process recurved, from above oblong (fig. 8) from the side with an enlarged, flattened tip which rests against tength tergite (fig. 8B). Subanal lobes complex, divided, innermost part curved upward and bearing spinules, outermost part also curving upward and outward into two processes, each bearing terminal tuft of spinules.

Female—In general features similar to male. Cerci unmodified. Abdominal segments all largely membranous. Seventh sternite with median subgenital plate evenly rounded, which extends rearward distance equal to about two-thirds length of the side of seventh sternite proper.

Holotype male, *allotype* female, two male *paratypes*: Kote, Kulu Valley, 8,000 ft., 20-VI-55, A. P. Kapur. One paratype in writer's collection. An additional male paratype as follows: Kote, Kulu Valley, 7,500 ft., 20-VI-55, Santokh Singh (SGJ, Jr).

Details of the male supra-a nal process distinguish this from other species in the subgenus *Amphinemura*.

Numerous nymphs with tufted cervical gills from Kote and from Rahla may belong to this species.

PERLODIDAE

PERLODINAE

10. **Perlodes amabilis** Jewett, new species

Length to wing tips: holotype female, 27 mm. Length of body: holotype female 18 mm.

General color brown with conspicuous yellow markings on head and prothorax and with partially brown fumose wings. Head at compound eyes as wide as greatest width of pronotum, with yellow markings as follows: large lateral band on clypeus, M-line which may be entire (the paratype) or broken into three parts (the holotyye), rear of the head with large rounded median area extending forward (fig. 9). Prothorax slightly wider than long, anterior angles more rounded than those of rear, with broad median yellow stripe that occupies about fourth width of pronotum, medially with dark line, shield on either side of yellow stripe dark brown, with even darker, scattered embossings. Mesosternal ridge pattern normal for genus. Wings rather strikingly colored when unfolded; outer half of fore wing brown, inner half hyaline with yellow veins, costal area most yellowish; hind wings similarly coloured, clear area extending into anal fan but with basal cell entirely fumose. Legs yellow to yellow-brown on outer faces of femur and tibia. Abdomen brown dorsally, yellow-brown ventrally. Cercal segments bicolored, yellow basally, dark brown apically. Female subgenital plate on eighth sternite trilobate, bassally recessed into rectangular area in posterior median area of sternite and with outermost, finger-like lobes extending well beyond distal, lateral margin of eighth sternite (fig. 9B). In paratype median lobe of plate smaller than that in figure. Pair of brown spots present near anterior border of eighth sternite in line with outer projections of subgenital plate.

Holotype female: Manali, 6,000 ft., 22-V-55, H. N Baijal. *Paratype* female: Manali, 6,500 ft., 25-VI-55, V. K. Gupta (SGJ, Jr).

The shape of the subgenital plate and the color pattern of the head and pronotum distinguish this species from the other described Asiatic members of *Perolodes*.

Several nymphs from the Kulu and Lahaul probably belong to this species.

ABSTRACT

Ten species of Plecoptera are recorded from the North-West (Punjab) Himalaya. One species, *Rhabdiopteryx lunata* Kimmins, was described from Mount Everest some 600 miles to the east. The following nine species are described as new ; *Leuctra (Rhopalopsole) magnicerca, Capnia manii, Nemoura (Nemoura) ampula, N. (N.) cordata, N. (N.) punctata, N. (N.) punjabensis, N. (Amphinemura) tricentha, N. rahlae*, and *Perlodes amabilis*. Author's abstract.

LEGEND FOR FIGURES

Fig. 1. *Leuctra magnicerca*, dorsal view of holotype male genitalia; 1A, lateral view of male genitalia. Fig. 2. *Capnia manii*, dorsal view of male genitalia ; 2A, lateral view of male genitalia ; 2B, terminal sternites of female. Fig. 3. *Nemoura ampula*, dorsal view of holotype male genitalia ; 3A, lateral view of male genitalia ; 3B, terminal sternites of female. Fig. 4. *Nemoura cordata*, dorsal view of male genitalia ; 4A. ventral view of male genitalia ; 4B, lateral view of male genitalia ; 4C, terminal sternites of female. Fig. 5. *Nemoura punctata*, dorsal view of male genitalia ; 5A, lateral view of male genitalia ; 5B, terminal sternites of allotype female. Fig. 6. *Nemoura punjabensis*, dorsal view of male genitalia ; 6A, ventral view of male genitalia ; 6B, lateral view of male genitalia ; 6C, terminal sternites of female. Fig. 7. *Nemoura rahlae*, terminal sternites of holotype female. Fig. 8. *Nemoura tricentha*, dorsal view of male genitalia ; 8A, ventral view of male genitalia ; 8B, lateral view of male genitalia ; 8C, terminal sternites of allotype female. Fig. 9. *Perlodes amabilis*, head and pronotum ; 9A, terminal sternites of female.

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